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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------|-------------|----------------------|----------------------|------------------|
| 09/935,776 | 08/22/2001 | Charles M. Lieber | H00498.70054/TJO/DPM | 8935 |

23628 7590 09/02/2003

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EXAMINER

HU, SHOUXIANG

ART UNIT

PAPER NUMBER

2811

DATE MAILED: 09/02/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

| | | | |
|------------------------------|--------------------------|------------------|--|
| Office Action Summary | Application No. | Applicant(s) | |
| | 09/935,776 | LIEBER ET AL | |
| | Examiner Shouxiang Hu | Art Unit 2811 | |

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) Responsive to communication(s) filed on 05 June 2003.
- 2a) This action is FINAL. 2b) This action is non-final.
- 3) Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) Claim(s) 1-333 is/are pending in the application.
- 4a) Of the above claim(s) See Continuation Sheet is/are withdrawn from consideration.
- 5) Claim(s) _____ is/are allowed.
- 6) Claim(s) 1,2,5-8,32-48,56-101,106-108,110,112,117-120,175,181,183,186-189,191,194,195 and 202 is/are rejected.
- 7) Claim(s) _____ is/are objected to.
- 8) Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) The specification is objected to by the Examiner.
- 10) The drawing(s) filed on _____ is/are: a) accepted or b) objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) The proposed drawing correction filed on _____ is: a) approved b) disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
 - a) All
 - b) Some *
 - c) None of:
 1. Certified copies of the priority documents have been received.
 2. Certified copies of the priority documents have been received in Application No. _____.
 3. Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.
- 14) Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
 - a) The translation of the foreign language provisional application has been received.
- 15) Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) Notice of References Cited (PTO-892)
- 2) Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) Information Disclosure Statement(s) (PTO-1449) Paper No(s) 7.

- 4) Interview Summary (PTO-413) Paper No(s). _____
- 5) Notice of Informal Patent Application (PTO-152)
- 6) Other: _____

U.S. Patent and Trademark Office
PTO-326 (Rev. 04-01)

Office Action Summary**Part of Paper No. 14**

Continuation of Disposition of Claims: Claims withdrawn from consideration are 3,4,9-31,49-55,102-105,109,111,113-116,121-174,176-180, 182, 184-185, 190,192-193, 196-201 and 203-333.

DETAILED ACTION

Election/Restrictions

1. Claims 3, 4, 9-15, 18-31, 49-55, 109, 121-174, 177-180, 184, 185, 190, 192, 103, 196-201, 261 and 262 are withdrawn from further consideration pursuant to 37 CFR 1.142(b), as being drawn to a nonelected invention, there being no allowable generic or linking claim. Applicant timely traversed the restriction (election) requirement in Paper No. 13. The traversal is on the ground(s) that Species 1, 2, and 3 do not appear to be mutually exclusive, nor do Species 1, 2, and 4. This is not found persuasive because the arguments fail to submit or identify evidence as to why these species are not mutually exclusive. According to MPEP § 809.02(a), should applicant traverse on the ground that the species are not patentably distinct, applicant should submit evidence or identify such evidence now of record showing the species to be obvious variants or clearly admit on the record that this is the case. In this case, materials such as Se of Species 1, B-C of Species 2, IV-IV of Species 3 and III-V of Species 4 are apparently mutually exclusive, for being substantially different in composition and properties.

The requirement is still deemed proper.

In addition, claims 16, 17, 102-105, 111, 113-116, 176 and 182 are also withdrawn from further consideration pursuant to 37 CFR 1.142(b), as being unreadable on the elected species. These claims each recite one or more of the subject matters of: a IV-VI semiconductor (claims 16 and 17), spin-polarized semiconductor (claims 102 and 103), light-emitting semiconductor (claims 104 and 105), two mutually manipulative

nanowires (claims 111), p-n junction device (claims 113-116), two coupled nanowires (claim 176), and/or a magnetically coupled (claim 182). And, none of these subject matters is/are readable on the elected species of a IV-IV semiconductor readable in a device of a field effect transistor.

Accordingly claims 1-333 are pending in this application; and claims 1, 2, 5-8, 32-48, 56-101, 106-108, 110, 112, 117-120, 175, 181, 183, 186-189, 191, 194, 195, 202 remain active in this office action.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

3. Claims 99-101 and 106-108, as being readable on applicant's elected species, are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Claims 99-101 and 106-108 recite the subject matter(s) of a bulk-doped semiconductor that exhibits coherent transport, no scattering, ballistic transport and/or Luttinger liquid behavior. However, the specification lacks an adequate description regarding how a doped IV-IV semiconductor can still possess such recited

characteristics, and how a material with such characteristics can still be used in the elected species of a filed effect transistor.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

5. Claims 1-2, 7, 32-39, 42-48, 56-59, 72-74, 76-83, 85-94, 96-101, 106-108, 110, 117-120, 183, 186-189, 191, 194-195 and 202, insofar as being in compliance with 35 U.S.C. 112, are rejected under 35 U.S.C. 102(a) as being anticipated by Chung et al. ("Chung"; Applied Physics Letters, V76, N15, p2069-2070).

Chung discloses a device including a filed effect transistor (see Fig. 1), comprising: a doped semiconductor (p-type doped single crystal silicon nanowire; having a diameter as small as 14 nm, and a length as long as 10 um, see the first column); and an exterior shell (oxide coating).

It is noted that, in the instant specification, the term of a "free standing" article is defined as meaning: an article that at some point in its life it is not attached to another article or that is in solution (see page 35, lines 1-2). Accordingly, the term of "free-standing" recited in the claims is hereby regarded as a process limitation, as all meaningful utilities found in the instant disclosure are at the non-free-standing state. The limitations of "freer-standing" and "bulk-doped" recited in the claims are hereby

treated as process limitations, and they would not carry patentable weight in the claims drawing to a structure, because distinct structure is not necessarily produced. In re Thorpe, 227 USPQ 964, 966 (Fed. Cir. 1985).

Furthermore, regarding claims 87-89, the recited limitations therein regarding how the semiconductor are formed are process limitations, and they would not carry patentable weight in the claims drawing to a structure, because distinct structure is not necessarily produced. In re Thorpe, 227 USPQ 964, 966 (Fed. Cir. 1985).

Regarding claim 7, a silicon semiconductor can be regarded as a Si-Si IV-IV semiconductor.

Regarding claims 99-101 and 106-108, insofar as being in compliance with 35 U.S.C. 112, the Si nanowire in Chung naturally has the characteristics substantially same as that of the claimed invention, as they both have a material and dimension substantially the same to each other.

6. Claims 77, 79, 83-91 are further rejected under 35 U.S.C. 102(a) as being anticipated by Wolf et al. ("Wolf"; Silicon Processing for the VLSI Era, Lattice Press, V1, pages 12-13).

Wolf discloses (pages 12-13) a semiconductor to be used in a device, comprising a doped silicon single crystal (either n- or p-type bulk-doped).

Regarding claims 87-89, the recited limitations therein regarding how the semiconductor are formed are process limitations, and they would not carry patentable

weight in the claims drawing to a structure, because distinct structure is not necessarily produced. In re Thorpe, 227 USPQ 964, 966 (Fed. Cir. 1985).

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

8. Claims 40-41, 70-71, 75, 95, 112, 175 and 181 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chung.

The disclosure of Chung is discussed as applied to claims 1-2, 7, 32-39, 42-48, 56-59, 72-74, 76-83, 85-94, 96-101, 106-108, 110, 117-120, 183, 186-189, 191, 194-195 and 202 above.

Chung does not expressly disclose that the diameter of a semiconductor nanowire can be as small as 5 nanometers (as recited in claims 40, 41, 70 and 71), that the semiconductor can also be n-type doped (as recited in claims 75 and 95), that the device can have another such semiconductor (recited in claim 112), and/or that the device can have another semiconductor in contact with the semiconductor nanowire (as in claims 175 and 181).

However, one of ordinary skill in the art would readily recognized that the diameter of a semiconductor nanowire can be desirably as small as less than 5 nm for further reducing the device size, as evidenced in the prior art such as Morales et al.

(Science, V279, pages 208-211, which discloses a nanowire having a diameter of 3 nm); that a semiconductor can desirably be of an n-type for forming a device in combination with and/or in complementary to the p-type one (such a pn-junction type devices and/or CMOS type devices); that the device can have multiple nanowire field effect transistors integrated to form desired circuit; and that the source and/or drain electrode in a field effect transistor can be readily formed with another semiconductor as an electrode for improved electrode material choice and flexibility.

Therefore, it would have been obvious to one of ordinary skill in the art to make the nanowire device of Chung with that the semiconductor nanowire is reduced to as small as less than 5 nm for further reducing the device size; that a semiconductor is made of an n-type for forming a device in combination with and/or in complementary to the p-type one; that the device have multiple nanowire field effect transistors integrated to form a desired circuit; and that the source and/or drain electrode is/are formed with another semiconductor for improved electrode material choice and flexibility.

9. Claims 1, 2, 5-8, 32-48, 56-101, 106-108, 110, 112, 117-120, and 202, insofar as being in compliance with 35 U.S.C. 112, are rejected or further rejected under 35 U.S.C. 103(a) as being unpatentable over Morales et al. ("Morales"; Science, V279, pages 208-211) in view of Heath et al. ("Health"; US 2001/0054709 A1).

Morales discloses a semiconductor (a nanowire; single crystal Si or Ge; formed through a free-standing process; and with a diameter as small as 3 nm and a length up

to 30 um), and an exterior shell (silicon oxide). Morales further discloses that the semiconductor can also be formed with SiC).

Although Morales does not expressly disclose that the semiconductor can be doped to become either p-type or n-type, one of ordinary skill in the art would readily recognize that a semiconductor normally has to be doped to become one of the two types for forming various functional semiconductor devices, as evidenced in Heath, which teaches to form a doped semiconductor nanowire (through a bulk-doping process, see section 0042 and 0045).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to make the semiconductor of Morales with the semiconductor being doped, as taught in Heath, so that a semiconductor device with desired functionality would be obtained.

Regarding claims 75, 76, 95 and 96, it is noted that one of ordinary skill in the art would readily recognize that a semiconductor can be readily doped to become either n-type or p-type.

Regarding claims 87-89, the recited limitations therein regarding how the semiconductor are formed are process limitations, and they would not carry patentable weight in the claims drawing to a structure, because distinct structure is not necessarily produced. In re Thorpe, 227 USPQ 964, 966 (Fed. Cir. 1985).

Regarding claims 99-101 and 106-108, insofar as being in compliance with 35 U.S.C. 112, the nanowire collectively taught in Morales and Heath would naturally have

the characteristics substantially same as that of the claimed invention, as they both have a material and dimension substantially the same to each other.

10. Claims 175, 181, 183, 186-189, 191, 194 and 195 are rejected under 35 U.S.C. 103(a) as being unpatentable over Morales in view of Heath, as applied to claims 1, 2, 5-8, 32-48, 56-101, 106-108, 110, 112, 117-120, and 202 above, and further in view of Tans et al. ("Tans"; Nature, V393, p49-52).

The disclosures of Morales and Health are discussed as applied to claims 1, 2, 5-8, 32-48, 56-101, 106-108, 110, 112, 117-120, and 202 above.

Although Morales and Health do not expressly disclose that the semiconductor nanowire can be incorporated into a field effect transistor, it is art-known that a field effect transistor can be desirably formed with a semiconductor nanowire for reducing the device size, as evidenced in the prior art such as Tans et al. (see Figs. 1-3).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to make the above collectively taught semiconductor nanowire and to incorporate it into a field effect transistor, as taught in Tans, so that a semiconductor device with a reduced size would be obtained.

Regarding claims 175 and 181, it is further noted that one of ordinary skill in the art would readily recognized that the device can have multiple nanowire field effect transistors integrated to form desired circuit; and that the source and/or drain electrode in a field effect transistor can be readily formed with another semiconductor device for improved electrode material choice and flexibility. Therefore, it would have been

obvious to one of ordinary skill in the art at the time the invention was made to make the above collectively taught nanowire device with multiple nanowire field effect transistors being integrated to form a desired circuit, and/or with the source and/or drain electrode being formed with another semiconductor for improved electrode material choice and flexibility.

Conclusion

11. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. References U-X in Page 2 of PTO-892 are cited as being related to a semiconductor nanowire.

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Shouxiang Hu whose telephone number is (703) 306-5729. The examiner can normally be reached on Monday through Thursday, 7:30 AM to 6:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tom Thomas can be reached on (703) 308-2772. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9318 for regular communications and (703) 872-9319 for After Final communications.

Art Unit: 2811

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

SH

August 10, 2003



SHOUXIANG HU
PRIMARY EXAMINER